

Orion Launch Abort System performance on Exploration Flight Test – 1

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This paper will present an overview of the flight test objectives and performance of the Orion Launch Abort System during Exploration Flight Test-1. Exploration Flight Test-1, the first flight test of the Orion spacecraft, was managed and led by the Orion prime contractor, Lockheed Martin, and launched atop a United Launch Alliance Delta IV Heavy rocket. This flight test was a two-orbit, high-apogee, high-energy entry, low-inclination test mission used to validate and test systems critical to crew safety. This test included the first flight test of the Launch Abort System performing Orion nominal flight mission critical objectives.

NASA is currently designing and testing the Orion Multi-Purpose Crew Vehicle (MPCV). Orion will serve as NASA's new exploration vehicle to carry astronauts to deep space destinations and safely return them to earth. The Orion spacecraft is composed of four main elements: the Launch Abort System, the Crew Module, the Service Module, and the Spacecraft Adapter (Fig. 1). The Launch Abort System (LAS) provides two functions; during nominal launches, the LAS provides protection for the Crew Module from atmospheric loads and heating during first stage flight and during emergencies provides a reliable abort capability for aborts that occur within the atmosphere.

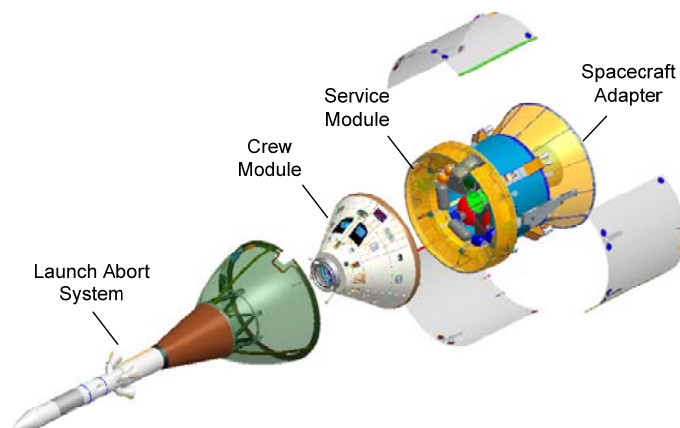


Figure 1. Orion Multi-Purpose Crew Vehicle.

The Orion Launch Abort System (LAS) consists of an Abort Motor to provide the abort separation from the Launch Vehicle, an Attitude Control Motor to provide attitude and rate control, and a Jettison Motor for crew module to LAS separation (Fig. 2). The jettison motor is used during a nominal launch to separate the LAS from the Launch Vehicle (LV) early in the flight of the second stage when it is no longer needed for aborts and at the end of an LAS abort sequence to enable deployment of the crew module's Landing Recovery System. The LAS also provides a Boost Protective Cover fairing that shields the crew module from debris and the aero-thermal environment during ascent.

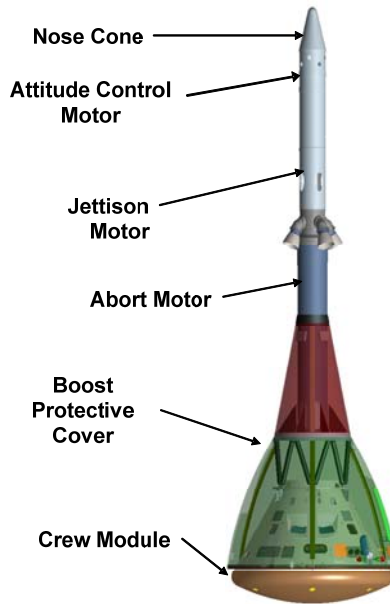


Figure 2. Launch Abort System and Crew Module.

Although the Orion Program has tested a number of the critical systems of the Orion spacecraft on the ground, the launch environment cannot be replicated completely on Earth. A number of flight tests have been conducted and are planned to demonstrate the performance and enable certification of the Orion Spacecraft. Exploration Flight Test 1, the first flight test of the Orion spacecraft, was successfully flown on December 5, 2014 from Cape Canaveral Air Force Station's Space Launch Complex 37. Orion's first flight was a two-orbit, high-apogee, high-energy entry, low-inclination test mission used to validate and test systems critical to crew safety, such as heat shield performance, separation events, avionics and software performance, attitude control and guidance, parachute deployment and recovery operations. One of the key separation events tested during this flight was the nominal jettison of the LAS. Data from this flight will be used to verify the function of the jettison motor to separate the Launch Abort System from the crew module so it can continue on with the mission.

The LAS nominal jettison event on Exploration Flight Test 1 occurred at six minutes and twenty seconds after liftoff (See Fig. 3). The abort motor and attitude control motors were inert for Exploration Flight Test 1, since the mission did not require abort capabilities. A suite of developmental flight instrumentation was included on the flight test to provide data on spacecraft subsystems and separation events. This paper will focus on the flight test objectives and performance of the LAS during ascent and nominal jettison. Selected LAS subsystem flight test data will be presented and discussed in the paper.



Figure 3. LAS Nominal Jettison during EFT-1.

Exploration Flight Test -1 will provide critical data that will enable engineering to improve Orion's design and reduce risk for the astronauts it will protect as NASA continues to move forward on its human journey to Mars. The lessons learned from Exploration Flight Test 1 and the other Flight Test Vehicles will certainly contribute to the vehicle architecture of a human-rated space launch vehicle.